TRANSPERFECT

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METHOD FOR TRANSMITTING DATA VIA A DATA TRANSMISSION UNIT AND DATA PROCESSING SYSTEM

Description

[001] This invention relates to a method of transmitting data via a data transmission unit between data processing units of a data processing system, e.g., a programmable controller for automation of an industrial installation, in particular a machine, a manufacturing plant or a power plant. The invention also relates to a data processing system.

[002] Data processing systems are used in a variety of ways in industrial automation processes, whereby in complex industrial installations, numerous data processing units are combined into complex computer networks and data networks via at least one data processing unit. So-called operator stations or operation and observation units are usually provided for operating and/or observing the data processing units that control the installation. Each data processing unit has data processing programs for controlling and/or regulating the industrial installation. The data processing program usually runs in the data processing units, e.g., in a central control unit, as well as in decentralized on-site controllers, of the industrial installation, controlling among other things the exchange of data between the central control unit and components of the industrial installation via the data transmission unit. First, switching commands or manipulated variables are transmitted via the data processing program to components such as actuators, while on the other hand, measured data or characteristic process parameters and/or operating parameters are read by the components such as sensors. Depending on the type and design of the industrial installation, a data processing unit may also gain access to the data processing program of another data processing unit.

[003] In data exchange via the data transmission system comprising at least one data transmission unit, e.g., a bus system, so-called control signals, address signals and data signals are usually transmitted between communication partners, e.g., between data processing units, according to protocols, i.e., rules for signal level and time specifications. As the complexity of data processing systems increases steadily due to a

constant increase in the number of functions, sensors and actuators, there is also an increase in the networking and thus the exchange of data or information, such as sensor data and control commands. The communication or data transmission system must have a high level of interference immunity, in particular for security-relevant functions, and must permit especially rapid data transmission.

[004] To achieve a high interference immunity in a communication, in particular in a communication of a central controller with local decentralized peripheral modules, the data is sent to the peripheral modules via a low-pass filter. This results in a limited bandwidth in the communication, thus limiting the data exchange with regard to the speed and volume of data. Therefore, a faster and faster data connection and/or data transmission is usually necessary to meet higher demands regarding data transmission between the central controller and the peripheral modules, for example, or higher demands regarding a connection to the Ethernet, Internet or a bulk memory. To this end, additional bus systems are usually employed in the automation system or the data processing system. However, it is especially complicated to expand the data processing system in this way by adding additional bus systems and it is particularly complex and maintenance-intensive with regard to coordination of the data exchange.

[005] Therefore, this invention is based on the object of providing a method of transmitting data via a data transmission unit between data processing units of a data processing system, which will permit particularly simple, rapid and reliable transmission. Another object is to provide a data processing system for digital signal processing.

[006] The first object defined above is achieved according to this invention by a method of transmitting data via a data transmission unit between data processing units of a data processing system, whereby data is transmitted in at least two protocols in parallel, such that when using a first protocol, data is transmitted in a first frequency range with a first signal sequence and a first signal level, and when using a second protocol, additional data is transmitted in a second frequency range with a second signal sequence and a second signal level. This allows both slow data exchange and rapid data exchange with the best

possible interference immunity using a single physical data transmission unit, which is therefore shared.

[007] This invention is based on the idea that with the steady increase in data volume and the resulting increase in demands with regard to data volume in data exchange while at the same time maintaining a very high level of interference immunity and a low hardware complexity, the efficiency of a single or pre-existing physical data transmission unit is to be increased. This requires fault-tolerant and deterministic data protocols with a high data integrity for selecting the data on which the data exchange is based according to various requirements with different protocol times and for separating the data according to protocol in the data transmission. In the data exchange, the data pertaining only to one protocol requirement is taken into account separately from data of another protocol requirement. The data belonging to the one respective protocol requirement is thus transmitted separately from data of other protocol requirements over one and the same data transmission unit with flexible utilization of a bandwidth, which characterizes the respective data transmission unit. The data is thus filtered according to the basic requirement, e.g., particularly high data integrity at a given data transmission rate or an especially high data transmission rate at a lower level of data integrity, and then the data is transmitted in separate protocols with regard to time, frequency and signal level. Thus in a data exchange between data processing units and/or operator units and observation units, the respective telegrams triggering the exchange are differentiated according to their interference immunity and/or their transmission rate, taking into account the use of the same data transmission unit, by using different frequency ranges. Consequently, a mutual influence of the data transmitted in the various protocols, in particular in different frequency ranges, is reliably prevented in a data exchange, thereby accelerating the exchange of all data to be taken into account.

[008] The data of the first protocol is expediently transmitted asynchronously with the acknowledgment signal (also known as a signal handshake). The data of the second protocol is preferably transmitted synchronously with the acknowledgment signal. This ensures that safety-relevant data in particular is transmitted with a particularly high interference immunity, and thus data of the first protocol is transmitted at a lower

interference immunity, separately from the data of the second protocol, using the same signals of the respective data transmission unit. Therefore, when data exchange of faster data is required, i.e., when establishing a connection between exchanging units, a so-called acknowledgment cycle is executed by exchanging acknowledgment signals, with only the existence of the so-called ready signal being checked for the period of time of the data exchange to maintain interference immunity. If the ready signal is switched during the data exchange, the telegram pertaining to the data of the second protocol is interpreted as being invalid and is discarded.

[009] Alternatively or additionally, the data of the second protocol is provided with security data. This ensures that in addition to the acknowledgment signal, the data exchange for the fast data of the second protocol is checked for security on the basis of the security data, e.g., on the basis of a cyclic block check (so-called cyclic redundancy check, abbreviated CRC) or a check bit or parity bit in the data telegram (so-called parity check).

[010] The data of the first protocol is expediently transmitted at a transmission rate of less than 20 mbps. For a particularly reliable separation of the data of the first protocol from the data of the second protocol, it is advantageously transmitted at a transmission rate of less than 640 mbps.

[011] For the best possible differentiation of data at different data transmission rates and to avoid the resulting integration effects in transmission on one and the same data transmission unit, such a switching level is assigned to a driver provided for the first protocol, this switching level being arranged symmetrically around an H level of a driver provided for the second protocol. An operating point of 2.5 V with a high level of 5 V and a low level of 0 V is preferably assigned to the driver for the first protocol. An operating point of 5 V with a high level of 6 V and a low level of 4 V is preferably assigned to the driver for the second protocol.

[012] The second object defined above is achieved according to this invention by a data processing system having a plurality of data processing units which are interconnected via a data transmission unit, data of different requirements being transmissible in at least

two protocols in parallel on the data transmission unit, such that data is transmitted in a first frequency range with a first signal sequence and a first signal level on the basis of a first protocol at the transmission end, and on the basis of a second protocol, additional data is transmitted in a second frequency range with a second signal sequence and a second signal level, a filter belonging to the respective protocol being provided at the reception end. Due to the separation of the data on the basis of the underlying type of transmission using different protocols, frequencies and levels and a filter which takes this into account on the reception end, this ensures that one and the same data transmission unit can be used for different data protocols. This reliably avoids a particularly complex and expensive data transmission system.

[013] The advantages achieved with this invention consist in particular of the fact that by bandwidth-optimized transmission of data at different data transmission rates on one and the same data transmission unit, a particularly efficient data transmission unit is ensured. An existing bus system intended for slow and particularly interference-immune data transmission can be used for high-speed data transmission at the same time by defining a faster protocol using the entire bandwidth of the bus system. A data transmission unit having such a design in a data processing system is suitable in particular for consistent and simple maintenance and is particularly economical and effective with regard to availability as well as its use as an automation system in safety-relevant installations.

[014] Exemplary embodiments of this invention are explained in greater detail on the basis of a drawing, in which:

[015] FIG 1 shows schematically a data processing system having a plurality of data processing units that are interconnected via a data transmission unit,

[016] FIG 2a, 2b shows schematically signal sequences for data with a first protocol and data with a second protocol.

[017] Corresponding parts in the two figures are provided with the same reference numbers.

[018] FIG 1 shows a data processing system 1 having a plurality of data processing units 2 that are interconnected via data transmission unit 4. For example, a programmable controller, a personal computer or some other data processing unit may serve as the data processing unit 2. The data transmission unit 4 is a standardized transmission line, e.g., an Ethernet coaxial cable, and also has standardized transmission elements (not shown) such as amplifiers, repeaters or bridges. The data processing units 2 are connected to a computer network by means of the data transmission unit 4.

[019] Each data processing unit 2 has computer programs or data processing programs installed on it, by means of which an industrial installation, e.g., a manufacturing plant or a machine tool, is controlled and/or monitored. The data processing program, also called the main program or user software, runs in the data processing unit 2 to trigger and/or detect inputs and/or outputs 6 of respective peripheral modules (not shown). Depending on the type and design of the data processing system 1, the data processing program of a central controller is used for operation and observation of the inputs and/or outputs 6 of decentralized data processing units 2. The decentralized data processing units 2 are designed as so-called on-site controllers for operation and observation of the respective inputs and/or outputs 6.

[020] The respective data processing program of the data processing systems 2 is modular in design and includes as objects a number of function modules, which take over self-contained control functions and/or regulating functions for the industrial installation. With increased networking of the data processing units 2 on the basis of the data transmission unit 4, which may be designed as a simple unit or a redundant system, there is an increase in the exchange of data D, which is necessary for processing the respective data processing programs. There are frequently different requirements with respect to the security and speed of the data transmission. For example, a particularly high interference immunity with slow data transmission is sufficient for safety-relevant functions, e.g., in controlling peripheral modules. On the other hand, the fastest possible data transmission with a low level of immunity is important for other control functions, e.g., in storage of a large volume of data.

[021] To ensure the various requirements, the respective data processing unit 2 includes at least one filter 8A and 8B at the reception end for the different data on which the data transmissions are based; these filters output the respective data D as a function of a protocol characterizing the respective data transmission. At the transmission end, the respective data processing unit includes an amplifier element 10 and, if necessary, a resistance element 12.

[022] For the data D, which is to be transmitted in a particularly interference-protected manner, the filter 8A is preferably designed as a low-pass filter which, at the reception end, filters out the data D of a first protocol having a first frequency range and a first signal sequence as well as a first signal level. To do so, the filter 8A includes a respective low-pass circuit, which is formed by diodes 14, a capacitor 16 and/or a resistor 18, and an amplifier element 20. The type and design of the filter 8A depend on the first frequency range, the first signal sequence and/or the signal level.

[023] For the data D, which is exchanged at the highest possible data transmission rate between the data processing units 2 and with a lower interference immunity than the data D of the first protocol, the filter 8B includes only an amplifier element 20. A low-pass filter may be omitted here. Depending on the type and design of the respective data processing unit 2, in particular the type of data D to be transmitted, the data processing unit 2 includes a communication module having the filters 8A and 8B. If the data processing unit 2 is provided only for a particularly reliable data exchange, then it has only the filter 8A. If the data exchange includes a plurality of different protocols, each having the respective frequency range, respective signal sequence and/or respective signal level, then the number of filters 8A , 8B will vary accordingly as a function of the number of protocols predefined.

[024] FIG 2A shows as an example a signal sequence for the data D of a first protocol for a slow data exchange, which is particularly immune to interference. FIG 2B, however, shows a signal sequence for the data D of a second protocol for a particularly rapid data exchange. In a data transmission, the data D to be exchanged between the data processing units 2 via the data transmission unit 4 is preferably transmitted in parallel in at least two

protocols such that the data D, e.g., the so-called "slow data" with regard to the transmission rate, is transmitted on the basis of the first protocol in a first frequency range with a first signal sequence and a first signal level, and the additional data D, e.g., the so-called "fast data," is transmitted on the basis of the second protocol in a second frequency range with a second signal sequence and a second signal level.

[025] The data D of the first protocol is transmitted asynchronously and with a "ready" acknowledgment signal (also called a signal handshake) and at a transmission rate of approx. 20 mbps for a so-called 32-bit data bus or approx. 5 mbps for a so-called 8-bit data bus. To separate the data D of the first protocol from the data D of the second protocol, the data is transmitted synchronously in a data transmission via one and the same data transmission unit 4 and with a "ready" acknowledgment signal and at a transmission rate of approx. 640 mbps for a so-called 32-bit data bus and/or at a transmission rate of approx. 160 mbps for a so-called 8-bit data bus.

[026] In establishing the connection (represented by the circle labeled with the number "1" in FIG 2B), an acknowledgment signal (so-called signal handshake) is exchanged in the second fast protocol, after which the data is transmitted synchronously (see data transfer phase in FIG 2B, indicated by the arrow labeled with the number "2"). In other words, in reading the data D, it is transmitted by the data transmission unit 4 with a rising edge of signal "RD" 20 ns after a falling edge of signal "RD" and is received by the respective data processing system 2 on the reception end. The circle labeled as "3" in FIG 2B represents the disconnect phase. If there is a switch of the "ready" signal to "high" in ongoing data transmission while the "RD" signal is at "low", then the data transmission of the data D of the second protocol is evaluated as invalid and is discarded. The data D of the second protocol is also provided with security data for the purpose of monitoring the data transmission, e.g., a parity check or a cyclic redundancy check. The signal sequences depicted in FIGS 2A and 2B show only one physical layer, but any number of logic layers may be superimposed on it.

[027] A driver for the first protocol representing data transmission of the data D also preferably has a switching level of 2.5 V with a high level (referred to below as the

H level) of 5 V and a low level (referred to below as the L level) of 0 V. To rule out integration effects, the switching level of the first driver for the first protocol is arranged symmetrically about an H level of a driver provided for the second protocol. To do so, preferably a switching level of 5 V with an H level of 6 V and an L level of 4 V is assigned to the driver for the second protocol. The filter 8A or the input for the driver of the first protocol is to be designed to be as overvoltage-proof as possible due to the driver provided for the second protocol with an H level of more than 5 V, which is higher than that of the driver of the first protocol. Depending on the type and number of protocols representing the data exchange, other levels or other values may be provided for the switching levels.

WHAT IS CLAIMED IS:

1. Method of data transmission of data (D) via a data transmission unit (4) between data processing units (2) of a data processing system (1), whereby data (D) is transmitted in parallel in at least two protocols, such that on the basis of the first protocol, the data (D) is transmitted in a first frequency range with a first signal sequence and a first signal level and on the basis of a second protocol, additional data (D) is transmitted in a second frequency range with a second signal sequence and a second signal level.

2. Method as claimed in Claim 1, wherein the data (D) of the first protocol is transmitted asynchronously and with an acknowledgment signal.

3. Method as claimed in Claim 1 or 2, wherein the data (D) of the second protocol is transmitted synchronously and with an acknowledgment signal.

4. Method as claimed in one of Claims 1 through 3, wherein the data (D) of the second protocol is provided with security data.

5. Method as claimed in any one of Claims 1 through 4, wherein the data (D) of the first protocol is transmitted at a transmission rate of approximately 20 mbps.

6. Method as claimed in any one of Claims 1 through 5, wherein the data (D) of the second protocol is transmitted at a transmission rate of approximately 640 mbps.

7. Method as claimed in any one of Claims 1 through 6, wherein a switching level that is symmetrical about an H level of a driver provided for the second protocol is assigned to a driver which is provided for the first protocol.

8. Method as claimed in Claim 7, wherein a switching level of 2.5 V with an H level of 5 V and an L level of 0 V is assigned to the driver for the first protocol.

9. Method as claimed in Claim 7 or 8, wherein a switching level of 5 V with an H level of 6 V and an L level of 4 V is assigned to the driver for the second protocol.

10. Data processing system (1) comprising a plurality of data processing units (2) which are interconnected via a data transmission unit (4), whereby the data (D) of different requirements is transmissible in parallel in at least two protocols on the data transmission unit (4), such that at the transmission end, the data (D) is transmissible on the basis of a first protocol in a first frequency range with a first signal sequence and a first signal level, and the additional data (D) is transmissible on the basis of a second protocol in a second frequency range with a second signal sequence and a second signal level, and a filter (8A, 8B) belonging to the respective protocol is provided for the data (D) at the transmission end.

2 pages of drawings attached

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Abstract of the Disclosure:

The invention relates to a method for transmitting data (D) in a particularly simple, secure and rapid manner, on a single data transmission unit in accordance with various requirements. According to the inventive method for transmitting data (D) between the data processing units (2, 4) of a data processing system (1) via a data transmission unit, data (D) is transmitted in a parallel manner in at least two protocols. The first protocol enables the data (D) to be transmitted within a first frequency range with a first signal sequence and a first signal level. The second protocol enables the additional data (D) to be transmitted within a second frequency range with a second signal sequence and a second signal level.

DRAWINGS PAGE 1

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[see source for FIG 1]

DRAWINGS PAGE 2

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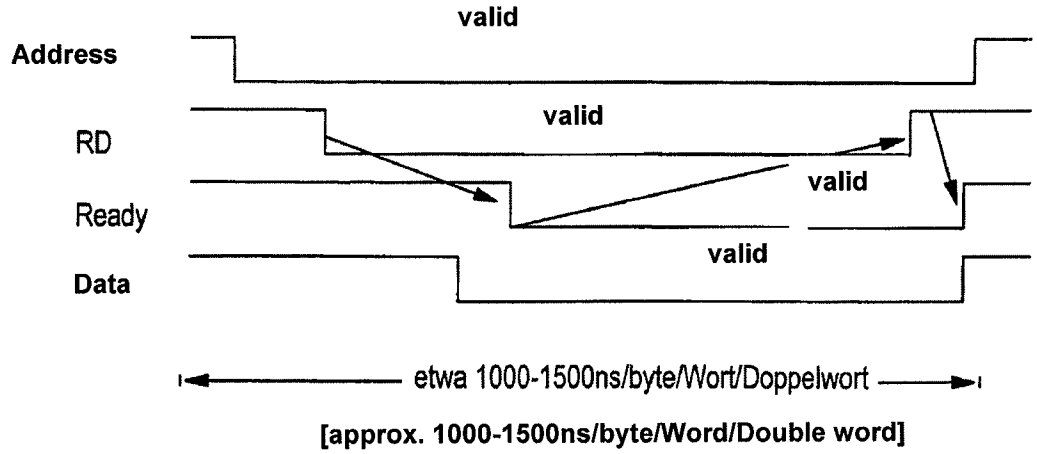

Fig. 2A

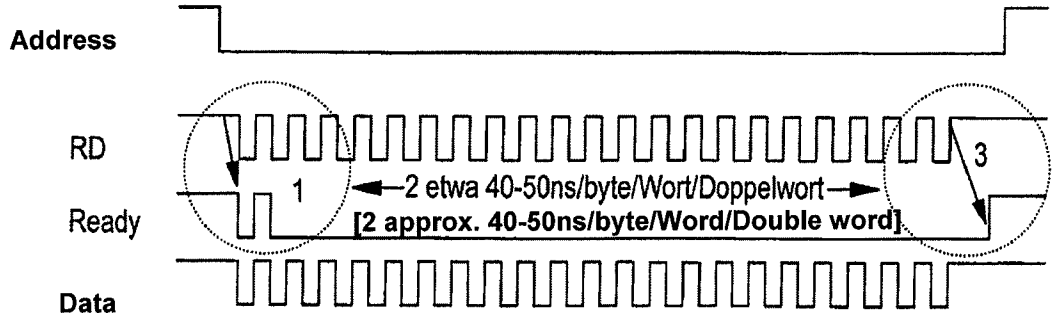

Fig. 2B